

CLAIMS

We claim:

1. A light modulator comprising:
 - a. elongated elements arranged parallel to each other and configured in a grating plane, each elongated element comprising a reflective surface such that in operation an incident light diffracts into at least two diffraction orders; and
 - b. means for adjusting a height of selected ones of the elongated elements relative to the grating plane such that in operation the incident light diffracts into a single diffraction order.
2. The light modulator of claim 1 wherein the means for adjusting the height of the selected ones of the elongated elements comprise:
 - a. a first conductive element along at least a portion of each of the selected ones of the elongated elements; and
 - b. a substrate coupled to the elongated elements, the substrate comprising a second conductive element such that an electrical bias applied between the first conductive elements and the second conductive element adjusts the height of the selected ones of the elongated elements.
3. The light modulator of claim 2 further comprising first and second posts, the first and second posts coupling the elongated elements to the substrate.
4. The light modulator of claim 1 wherein the selected ones of the elongated elements comprise every other ones of the elongated elements.
5. The light modulator of claim 1 wherein the reflective surfaces of each of the elongated elements comprise a blaze profile.

- 1 6. The light modulator of claim 5 wherein the blaze profile comprises at least
2 two planar surfaces.
- 1 7. The light modulator of claim 6 wherein the two planar surfaces comprise
2 planes parallel to the grating plane.
- 1 8. The light modulator of claim 5 wherein the reflective surface of the blaze
2 profile comprises a single planar surface at a blaze angle with respect to the
3 grating plane.
- 1 9. The light modulator of claim 1 wherein two times a width of each of the
2 elongated elements comprises a grating pitch.
- 1 10. The light modulator of claim 9 wherein the at least two diffraction orders
2 comprise a zeroth order diffraction and a second order diffraction.
- 1 11. The light modulator of claim 10 wherein the single diffraction order
2 comprises a first order diffraction.
- 1 12. A light modulator comprising:
2 a. elongated elements arranged parallel to each other and configured
3 in a grating plane, each of selected ones of the elongated elements
4 comprising a first conductive element, each elongated element comprising
5 a reflective surface such that in operation an incident light diffracts into at
6 least two diffraction orders; and
7 b. a substrate coupled to the elongated elements and comprising a
8 second conductive element such that in operation an electrical bias applied
9 between the first conductive elements and the second conductive element
10 adjusts a height of the selected ones of the elongated elements relative to
11 the grating plane and further such that in operation the incident light
12 diffracts into a single diffraction order.

- 1 13. A light modulator comprising:
- 2 a. elongated elements arranged parallel to each other in a grating
- 3 plane, each elongated element comprising a blaze profile, each blaze
- 4 profile comprising a reflective surface, each of selected ones of the
- 5 elongated elements comprising a first conductive element along the blaze
- 6 profile, the blaze profile comprising at least two planar surfaces, the two
- 7 planar surfaces comprising planes parallel to the grating plane such that in
- 8 operation an incident light diffracts into at least two diffraction orders; and
- 9 b. a substrate coupled to the elongated elements, the substrate
- 10 comprising a second conductive element such that, when an electrical bias
- 11 applied between the first conductive elements and the second conductive
- 12 element adjusts a height of the selected ones of the elongated elements, the
- 13 incident light diffracts into a single diffraction order.
- 1 14. A light modulator comprising:
- 2 a. means for diffracting an incident light into at least two diffraction
- 3 orders; and
- 4 b. means for adjusting the means for diffracting such that the incident
- 5 light diffracts into a single diffraction order.
- 1 15. A method of fabricating a light modulator comprising the steps of:
- 2 a. depositing a sacrificial layer on a substrate;
- 3 b. depositing a resilient material on the sacrificial layer;
- 4 c. depositing a reflective material on the resilient material;
- 5 d. etching the resilient material and the reflective material to form
- 6 elongated elements supported by the sacrificial layer, each elongated
- 7 element comprising at least two planar surfaces, the two planar surfaces of
- 8 each of the elongated elements comprising a blaze profile; and
- 9 e. etching the sacrificial layer to completion leaving the elongated
- 10 elements coupled to the substrate.
- 1 16. The method of claim 15 further comprising the steps of:

- 2 a. forming an oxide layer on the substrate between the substrate and
3 the sacrificial layer prior to depositing the sacrificial layer; and
4 b. depositing a conductive layer on the oxide layer between the oxide
5 layer and the sacrificial layer prior to depositing the sacrificial layer.

1 17. The method of claim 16 wherein the substrate comprises silicon and
2 further wherein the oxide layer comprises a field oxide layer of silicon dioxide.

1 18. The method of claim 16 further comprising the step of depositing an etch
2 stop on the conductive layer.

1 19. The method of claim 18 wherein the etch stop comprises silicon dioxide.

1 20. The method of claim 18 wherein the etch stop comprises silicon nitride.

1 21. The method of claim 16 wherein the conductive layer comprises doped
2 poly-silicon.

1 22. The method of claim 15 further comprising the steps of:

- 2 a. etching first post holes and second post holes through the
3 sacrificial layer; and
4 b. etching edges of the sacrificial material to form a delineated
5 sacrificial layer, thereby forming exposed underlying layers.

1 23. The method of claim 22 wherein sacrificial layer comprises poly-silicon.

1 24. The method of claim 23 wherein the step of etching the sacrificial layer to
2 completion comprises a xenon difluoride etch.

1 25. The method of claim 22 wherein the step of depositing the resilient
2 material further comprises depositing the resilient material within the first and

3 second post holes and depositing the resilient material on the exposed underlying
4 layers.

1 26. The method of claim 25 wherein the resilient material comprises silicon
2 nitride.

1 27. The method of claim 25 wherein each of the elongated elements comprise
2 a first end and a second end, the first and second ends of each of the elongated
3 elements coupled to the substrate by the underlying layers outside of the
4 delineated sacrificial layer.

5 28. The method of claim 15 further comprising the step of etching strips into
6 the sacrificial layer such that the strips etched into the sacrificial layer produce the
7 two planar surfaces of each of the elongated elements.

1 29. The method of claim 15 wherein the reflective material comprises
2 aluminum.

1 30. The method of claim 15 wherein the steps of depositing the reflective
2 material and etching the resilient material and the reflective material comprise the
3 steps of:

- 4 a. depositing a first layer of the reflective material;
5 b. etching the first layer of the reflective material to form strips of the
6 reflective material where the strips correspond to one of the planar
7 surfaces of the blaze profile of the elongated elements;
8 c. depositing a second layer of the reflective material; and
9 d. etching the resilient material and the reflective material to form the
10 elongated elements comprising the two planar surfaces.

1 31. A light modulator comprising:

- 2 a. elongated elements arranged parallel to each other and configurable
3 in groupings of the elongated elements, each elongated element

4 comprising a reflective surface such that in operation an incident light
5 illuminating the elongated elements produces a reflected light when the
6 elongated elements are at a first height, each of the groupings comprising
7 at least three of the elongated elements and each of the groupings
8 comprising an identical number of the elongated elements; and

- 9 b. means for adjusting a relative height of the elongated elements of
10 each of the groupings such that in operation the incident light illuminating
11 the elongated elements produces a single diffraction order.

1 32. The light modulator of claim 31 wherein the means for adjusting the
2 relative heights of the elongated elements of the groupings of the elongated
3 elements comprises:

- 4 a. first conductive elements along at least a portion of the elongated
5 elements; and
6 b. a substrate coupled to the elongated elements and comprising a
7 second conductive element such that in operation the relative heights of
8 the elongated elements of each of the groupings are adjusted by applying
9 individual electrical biases between the first conductive elements of the
10 grouping and the second conductive element.

11 33. The light modulator of claim 32 wherein the reflective surfaces of the
1 elongated elements comprises a metal and further wherein the metal comprises the
2 first conductive elements.
3

4 34. The light modulator of claim 31 wherein the groupings of the elongated
5 groupings comprise variable groupings of the elongated elements such that in
6 operation first groupings of three of the elongated elements produce the single
diffraction order at a first diffraction angle and further such that second groupings
of four of the elongated elements produce the single diffraction order at a second
diffraction angle.

1 35. The light modulator of claim 31 wherein the means for adjusting the
2 relative height of the elongated elements of each of the groupings is configured
3 such that in operation the single diffraction order occurs at a diffraction angle
4 selectable between a first diffraction angle and minus the first diffraction angle.

1 36. A light modulator comprising:

2 a. elongated elements arranged parallel to each other and configured
3 in groupings of the elongated elements, each elongated element
4 comprising a reflective surface and a first conductive element, each of the
5 groupings comprising at least three of the elongated elements and each of
6 the groupings comprising an identical number of the elongated elements;
7 and

8 b. a substrate coupled to the elongated elements, the substrate
9 comprising a second conductive element such that in operation an incident
10 light illuminating the elongated elements produces a reflected light when
11 the elongated elements are at a first height and further such that in
12 operation a relative height of the elongated elements of each grouping are
13 adjusted to produce a single diffraction order when individual electrical
14 biases are applied between the first conductive elements of each of the
15 groupings and the second conductive element.

1 37. A light modulator comprising:

2 a. means for reflecting an incident light; and

3 b. means for adjusting the means for reflecting such that the incident
4 light diffracts into a single diffraction order having a variable diffraction
5 angle.